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MOTOROLA

MOTOMESH™ Duo

A Next Generation Meshed WiFi Solution

SOLUTION BRIEF

CONTENTS

Executive Summary

Motorola's MOTOMESH Duo is a high performance, meshed WiFi solution designed to meet strict cost per square mile and ROI targets. MOTOMESH Duo is part of the MOTOwi4™ portfolio of broadband wireless access technologies, and delivers a new level of economic flexibility and investment protection to municipalities and service providers. Available in single or two radio configurations, MOTOMESH Duo leverages Motorola's field proven, MeshConnex™ routing engine and MeshManager™ element management system to meet the challenges of demanding multi-use networks. Its small size, minimal visual impact and low power consumption increases mounting location flexibility and enables rapid deployment.

Motorola's mesh networking technology[1] enables users to wirelessly access broadband applications seamlessly – virtually any time and anywhere. Whether providing wireless access to a campus, municipality or residential neighborhood, Motorola's mesh networking technology delivers real-time data to your employees, customers and constituents. Mesh networking technology significantly reduces the backhaul costs of wide scale networks and leverages millions of WiFi enabled devices already deployed globally.

Deploying large scale mesh networks requires meeting several unique needs, from an individual user's need for ease-of-use to an administrator's need for easy installation, high security and faster deployment. When picking a wireless mesh system the following questions must be considered. How scalable is the system? Can it support video and VoIP? Does the mesh system provide end-to-end data security? Is the system easy to manage? Does it meet industry standards? Is the system easy to deploy? Can the system support multiple user groups?

This paper describes the key attributes of the MOTOMESH Duo radio and how it meets all the above factors while still being the most cost-effective, turnkey mesh products available on the market.

[1] To learn more about Motorola's Mesh Networking Technology go to http://www.motorola.com/mesh/pdf/wp_technology_position_paper.pdf

MOUNTING FLEXIBILITY

MOTOMESH Duo has one of the smallest and lightest form factors in the market. As a result, municipalities and network operators benefit from increased mounting flexibility and rapid deployment, which can reduce deployment costs and deliver a quicker ROI. At under 5 lbs, with a volume approximately one eighth of a cubic foot, a single person can quickly and safely install these devices on streetlights, buildings, water towers, or a wide variety of other readily available structures. In addition, MOTOMESH Duo unit enclosures are NEMA 4 certified (European equivalent IP66), ensuring protection against windblown dust, rain, sleet, snow and many other environmental hazards.

Size is approximately 9"x 6"x 3.5"

MOTOMESH Duo Network Overview

A typical MOTOMESH Duo Network solution incorporates:

- Outdoor Intelligent Access Points (IAPs) which act as a bridge between the wired world and wireless mesh network. The IAPs serve as a gateway for the associated Mesh Wireless Routers (MWRs) and they act as a transition point to the injection layer (backhaul such as Motorola's Canopy Wireless Broadband™).[2]
- Mesh Wireless Routers which extend the mesh coverage wirelessly.
- MeshManager Element Management System, a network management application used to configure and manage MOTOMESH access points and Mesh Wireless Routers.
- MeshPlanner software for network planning, design and optimization.

Flexible Design – Single Radio or Two Radio Solution

MOTOMESH Duo is available either in a single radio configuration (Figure 1) with a 2.4 GHz WiFi radio (802.11 b/g) or in a two radio configuration (Figure 2) with an additional 5.8, 5.4 or 4.9GHz (802.11a) radio. In a single radio configuration, the 2.4 GHz radio is used for both client access and node-to-node mesh links. In the two radio configuration, the 5.8 or 5.4GHz radio is dedicated for node-to-node mesh traffic, while the 2.4 GHz radio is used for client access. Additionally, the 5.8 or 5.4GHz radio can be configured to provide client access using the 802.11a standard.

[2] To learn more about Motorola's Canopy Wireless Broadband go to http://motorola.canopy.wireless.com

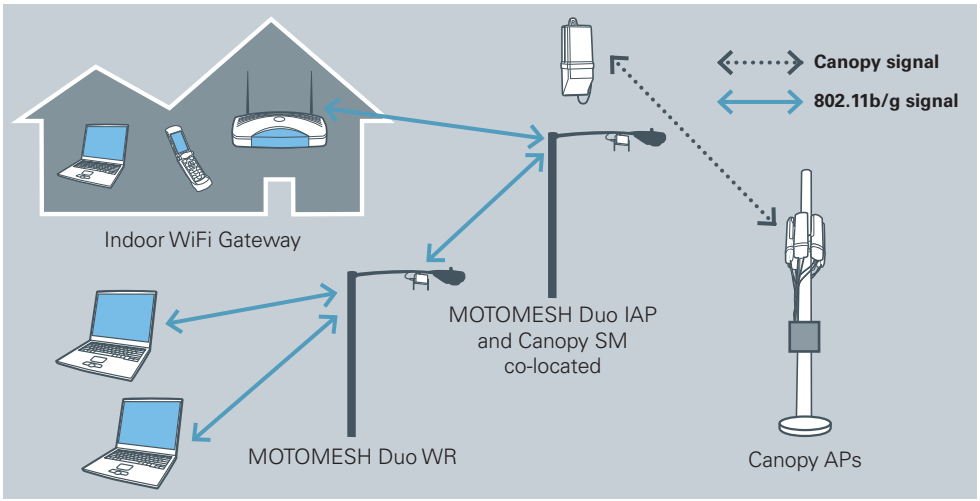


Figure 1:
MOTOMESH Duo:
Single Radio Solution

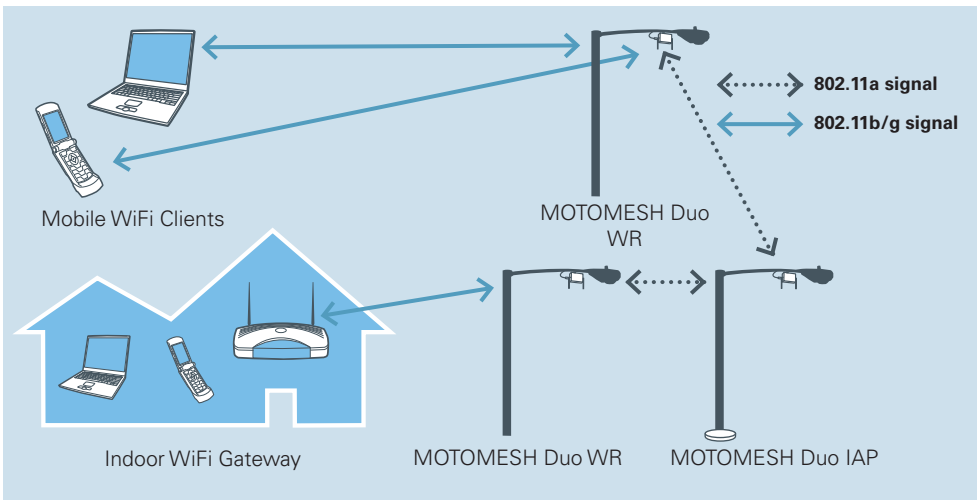


Figure 2:
MOTOMESH Duo:
Two Radio Solution

There are benefits to each of the configurations, and decisions should be made based on user requirements. The two radio configuration can improve overall network throughput, reduce latency and enable more clients to be served by a single backhaul link.

The single radio solution provides excellent performance at a low cost per square mile. In a single radio solution, when a wired backhaul is not available, a wireless backhaul system such as a Motorola Canopy link can be used to backhaul a cluster of MOTOMESH Duo nodes. With Canopy backhaul, MOTOMESH Duo wireless routers and access points can be deployed with only the 802.11b/g radio enabled and still deliver excellent performance at a low cost per square mile. If there is a need to increase capacity in the future, the second 5.8 GHz radio can be turned on by purchasing a software key. This flexible product design allows network operators to tailor installations to efficiently meet the bandwidth demands of remote and mobile businesses, municipal users, and residential subscribers.

System Features

Routing

The performance of a large scale mesh network architecture is highly dependent upon the characteristics of the routing engine it uses. The MOTOMESH Duo system leverages Motorola's MeshConnex technology – a proven, high performance, routing and radio link adaptation engine. MeshConnex has been successfully deployed in many cities worldwide and is also utilized by Motorola's award winning Mobility Enabled Access (MEA®) and other MOTOMESH™ wireless broadband products.

When WiFi access points are enhanced with Motorola's MeshConnex software, they turn into a powerful, interconnected network that can blanket a campus, downtown or entire city with wireless broadband access. These access points not only deliver WiFi to users, they also act as router repeaters for other access points in the network. The result is a self-forming, self-healing wireless broadband cloud that reduces the cost of backhaul, deployment and system engineering.

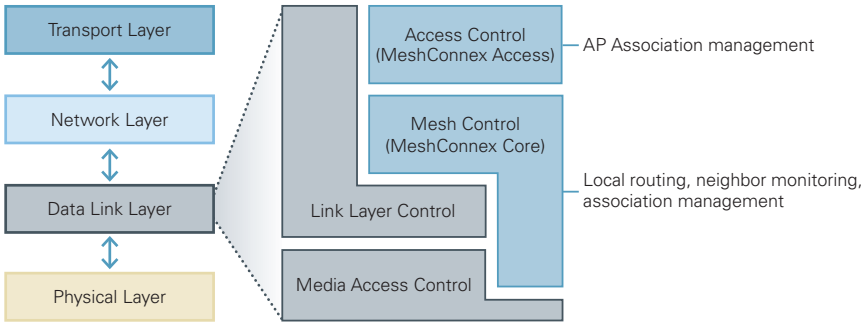


Figure 3: Wireless Communication Stack with MeshConnex Integration

MeshConnex routing software leverages Motorola's patented layer 2 routing techniques. Its layer 2 approach delivers several key benefits, including:

- Low hop latency for support of delay sensitive applications like VoIP and video
- Complete transparency to the IP layer, which means native support for IPv6 specifications
- Faster route convergence meaning route changes can be made in milliseconds rather than seconds
- Tighter integration with layer 1 radio metrics, ensuring better performance and scalability
- Proactive congestion and interference mitigation for better customer realized throughput
- Support for session-persistent client mobility, enabling the user to stay connected to VPN sessions when moving from one node to another

MeshConnex is made up of several key elements:

Mesh Scalable Routing (MSR™)

At the heart of Motorola's MeshConnex networking technology is a highly efficient routing protocol, Mesh Scalable Routing, designed specifically for use in Multi-Hopping™ wireless mesh networks. MSR technology enables dynamic, self-forming, self-healing, Multi-Hop routing between nodes in a network.

Routing algorithms are typically classified as either proactive or reactive. Proactive algorithms maintain a current list of routes to each node in the network, while reactive algorithms maintain no route information, but discover or create the most efficient route when a data packet is sent.

Proactive routing algorithms benefit from faster routing times, since all routing information is constantly kept current. But this class of algorithm scales poorly. As the size of the network increases, the messaging overhead required to constantly update route information for each node in the network would eventually overwhelm network capacity.

By contrast, reactive algorithms scale well for large numbers of nodes, but have significant overhead costs associated with establishing new routes. Additionally, reactive algorithms lead to initial route setup delay, on a per-packet basis, which may not be suitable for latency sensitive applications, like VoIP.

The MSR protocol is a hybrid routing algorithm that proactively discovers routes for nearby access point nodes, while using reactive routing techniques to discover nearby router nodes. By leveraging the key benefits of both proactive and reactive routing techniques, MSR's hybrid routing algorithms provide an optimal balance between latency, scalability, mobility and higher throughput. Hybrid routing also delivers ultra-fast route convergence while minimizing overhead on a per-node and system-wide basis. The situation-aware routing algorithm used in the MSR protocol greatly enhances the scalability of the network, while supporting high mobility in real world, wide area networks.

Adaptive Transmission Protocol (ATP™) Services

Many environmental conditions, such as multi-path, shadowing, fast fading, and interference (both intentional and unintentional) can affect data transmitted wirelessly. These conditions can lead to excessive packet loss at the receiver, particularly for broadband data in a multi-hopping large network. The purpose of ATP services is to enable the MSR protocol to balance the requirements of a reliable transmission while assuring the highest data throughput rate possible on a packet-by-packet basis.

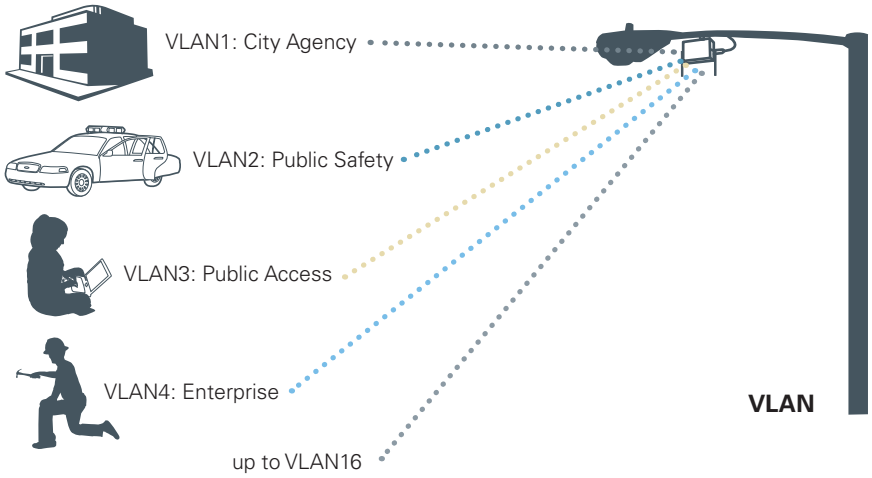
MSR/ATP technology intelligently optimizes the combination of link reliability and data rates in order to minimize energy use and system interference, while simultaneously maximizing data throughput and spectrum efficiency.

Virtual Network Mapping (VNM)

VNM allows various client groups and network operators to share a common MOTOMESH Duo network infrastructure by setting up their own private network within the system. VNM offers individual address spaces, classes of service and security settings to these users. In a municipal WiFi network, VNM allows for individual municipal agencies to administer their own virtual networks separately from the public access network. In a public access environment, VNM can separate different user groups such as businesses, residential customers and visiting nomadic users. Each user group is assured that their data will be isolated from other user groups sharing the network. Running multiple user groups on MOTOMESH Duo network opens up multiple business models and maximizes return on investment by leveraging capital expenditures and common operating expenditures across more paying customers.

Additionally, in a public/private partnership, network operators can partition the network per municipal requirements, while also sharing the network amongst a number of service providers (i.e. wholesale business model). With VLAN mapping, the network can be scaled up to 16 (broadcast and non-broadcast) SSIDs.

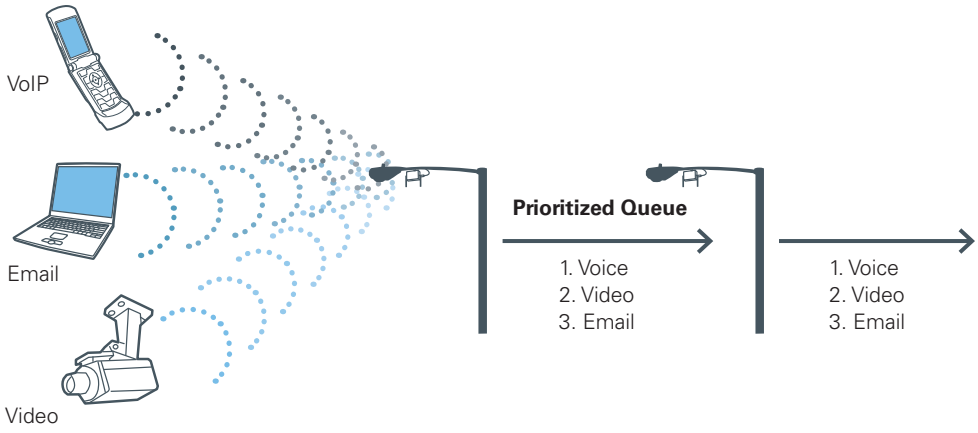
Figure 4. MOTOMESH Duo supports 16 VLANs per node



Quality of Service

Quality of Service (QoS) is a very important factor in determining the capability of a network device to support delay-sensitive applications like wireless voice over IP (VoIP) and streaming multimedia. The MOTOMESH Duo system fully supports the four queue priorities as defined in the IEEE 802.11e standard. The four queues can be used to assign higher priorities to applications with low tolerance for latency and jitter, such as VoIP, and streaming video and lower priority to less time sensitive applications, such as emails.

Figure 5. Traffic Prioritization by QoS as defined in IEEE 802.11e



Since the IEEE 802.11e standard does not address node-to-node QoS management in a mesh network, Motorola has developed and implemented several additional QoS features that extend QoS management and functionality into a meshed environment. Specifically, MOTOMESH Duo utilizes proprietary Traffic Congestion Detection to maintain and further enhance QoS for traffic passing between mesh nodes. Traffic Congestion Detection continuously monitors node congestion and automatically tunes QoS parameters and route selection.

In addition, the MOTOMESH Duo system also offers QoS Classification in accordance with the Differentiated Services Code Point (DSCP, or "DiffServ") specifications. The users can configure QoS priorities using either DSCP or VLAN tags.

Using a combination of IEEE 802.11e, VLAN and proprietary mesh QoS enhancements allows MOTOMESH Duo to robustly support latency sensitive applications like VoWLAN and Streaming Video.

Multi-Layer Security

The MOTOMESH Duo Security implementation is comprised of three levels of security, at the client level, intra-mesh node level and through the element management system.

Client security represents the security provided to traffic flow from the subscriber to the nearest mesh nodes. At the client level, MOTOMESH Duo supports WEP, WPA and WPA2 (IEEE 802.11i standards). WPA2 is the strongest standard to date and supports a very robust advanced encryption standard (AES) level designed for newer hardware clients.

The IEEE 802.11i standard does not define inter-nodal mesh security leaving node-to-node traffic in a mesh network vulnerable to attack. To provide complete airlink security, Motorola has addressed this vulnerability via its powerful SecureMesh™ encryption technology. This technology ensures that all data, including user, routing and management information traversing the mesh is secure, authenticated, and encrypted. SecureMesh technology uses enterprise-class AES encryption that is similar to the highest level of security available with 802.11i. What this means for clients is that regardless of the client's individual security settings, MOTOMESH Duo applies the highest security encryptions within the network, ensuring that packets delivered at the other end have the hightest security standards that other clients can accept. For example, clients using WEP will have the benefit of using a much stronger security and encryption level as their traffic traverses the mesh network.

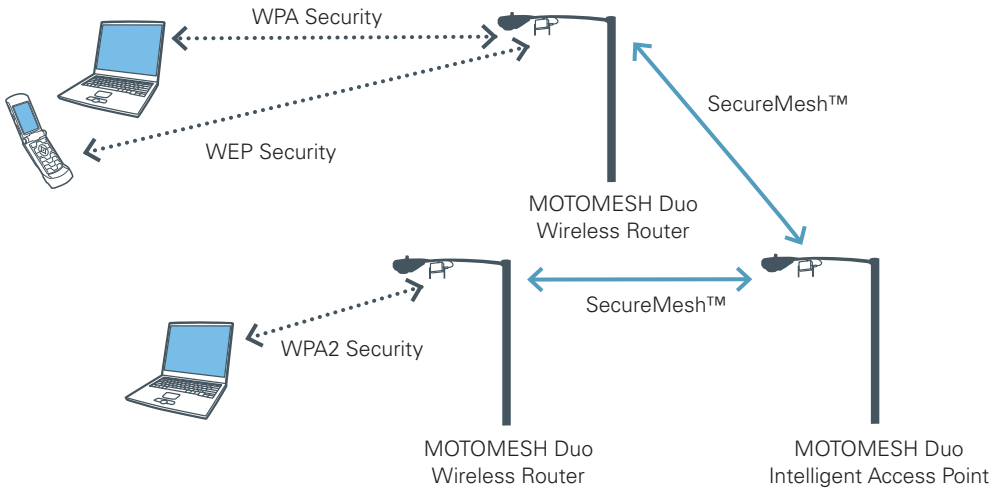


Figure 6. End-to-End security with IEEE 802.11i and SecureMesh™ support

In addition to the above security measures, MOTOMESH Duo uses SNMPv3 for Element Management System (EMS) messaging. This provides secure access to devices by a combination of authenticating and encrypting packets over the network.

SNMPv3 provides three security features:

Message integrity – to ensure that the packets have not been tampered with while in transit
Authentication – to ensure authenticity of messages
Encryption – scrambling contents of packets to prevent viewing by unauthorized sources
All these security elements ensure that the integrity of end-user and network management content is protected throughout the MOTOMESH Duo network from end to end.

Enterprise-class Filtering

MOTOMESH Duo is designed to filter broadcast storms coming in as errors or network loops, and those created by an application connecting through any wireless node. Each node is set with a threshold level, and will block such storms at the port until the rate decreases to an acceptable threshold level. The system is designed to control broadcast, unicast and multicast storms.

Moreover, TCP/IP port filtering selectively allows enabling or disabling TCP and UDP on network devices. When used in conjunction with other security practices, it insulates servers from many TCP/IP-based security attacks, including internal attacks from malicious users.

Key Radio Characteristics

Maximum Output Power for Better Coverage

MOTOMESH Duo's radios deliver 36 dBm Effective Isotropic Radiated Power (EIRP), the FCC's maximum allowable transmit power. EIRP is the actual power transmitted after taking into account all cable losses and antenna gain. Maximum allowable EIRP ensures that each MOTOMESH Duo access point has the capability to cover wider areas resulting in a lower number of nodes per square mile. An example of how EIRP translates into performance is measured in range improvement capabilities. All other criteria being the same, a MOTOMESH Duo radio that delivers 36 dBm has four times the transmission power of other competing radios offering 30 dBm EIRP transmit power, thus resulting in substantially higher propagation characteristics.

Excellent Receiver Sensitivity for Better Client Experience

Receiver sensitivity refers to the minimum signal power level that is necessary for the router's receiver to accurately decode a signal. This is an important factor in a WiFi environment because often the weak link of a network is the lower transmit power of the client subscriber's wireless adapters and not the transmit power of the radio. In order to overcome this limitation, access points or routers should have maximum possible receiver sensitivity in order to communicate with the subscribers at lower signal strength thresholds. MOTOMESH Duo has industry-leading receiver sensitivities of -77 dBm (at 54 Mbps) and -100 dBm (at 1 Mbps). MOTOMESH Duo's stronger receiver sensitivity coupled with maximum possible EIRP assures robust client connections, better client throughput, and a lower number of nodes per square mile ensuring lowest total cost-of-ownership.

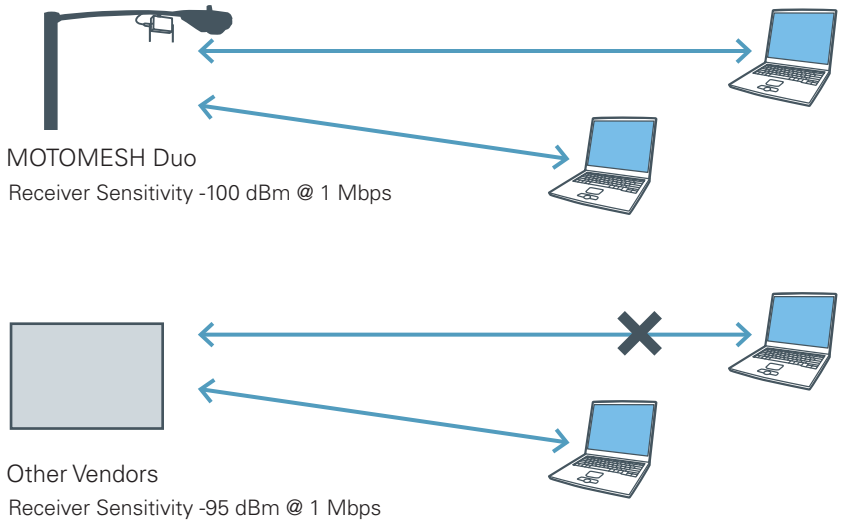
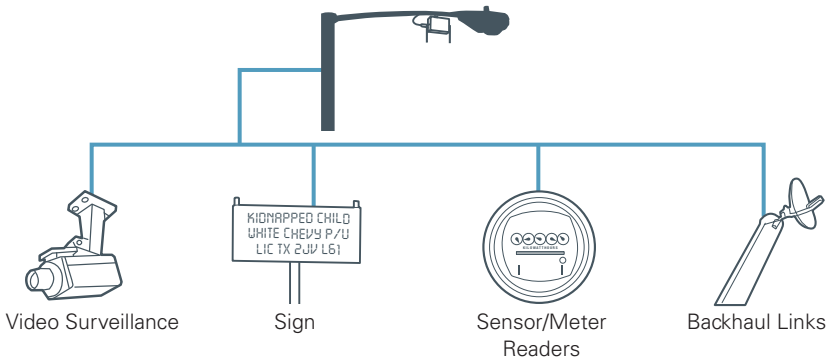


Figure 7. Best-in-class receiver sensitivity for better client connections

Support for Co-located Devices

To further support the deployment of value added services and devices, each MOTOMESH Duo Wireless Router is equipped with a configurable Ethernet port that supports Power over Ethernet (PoE). This enables devices like IP video cameras to be connected to and powered directly from a MOTOMESH Duo node. PoE can also be configured to directly support the special requirements for Motorola Canopy units as well via its CanopyConnect feature, providing a seamless integration for co-location of Canopy capacity injection units.

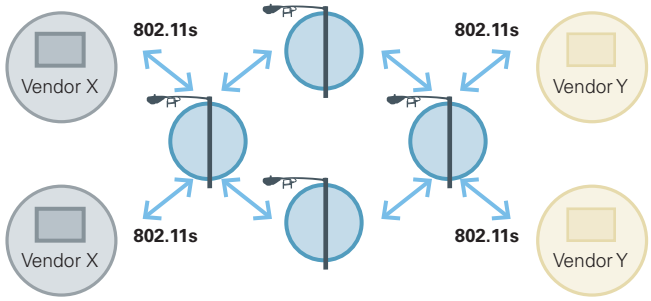
Figure 8. Configurable Ethernet port with PoE and CanopyConnect™ support

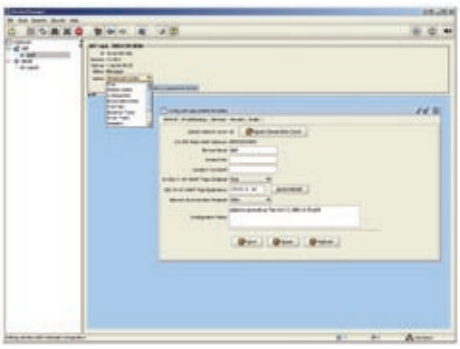


Support for IEEE 802.11s Standard – Powerful Investment Protection

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) is creating a new standard for meshing WiFi systems, known as IEEE 802.11s. This standard is being developed to define common features in a mesh system and to ensure interoperability between mesh network equipment vendors. MOTOMESH Duo networks are designed to support the final IEEE 802.11s standard via a simple over-the-air firmware update. Motorola's commitment to standards, interoperability and the latest technology helps protect your investments.

Figure 9. IEEE 802.11s support for vendor interoperability



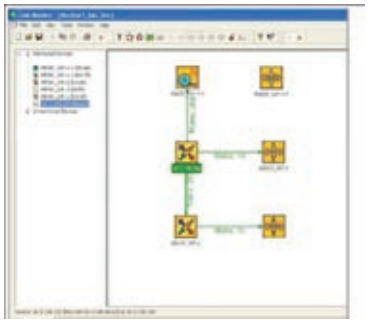


MOTOMESH Duo MeshManager Screenshot

Network Management

MeshManager Element Management System

MOTOMESH Duo also leverages MeshManager – Motorola's widely deployed, carrier class Element Management System (EMS). MeshManager is a GUI based application which provides a powerful interface to configure and manage MOTOMESH nodes, apply security policies, enable event logging and alarm management, and determine the status of the nodes real-time. MeshManager also supports over-the-air software updates, making network upgrades as easy as a click of the button. For provisioning large numbers of devices, administrators can create configuration templates to simplify and expedite deployment.



LinkMonitor Screenshot

MeshPlanner Screenshot

Link Monitor

Link Monitor is a system analysis and deployment assessment tool that can be used to observe various metrics, like RSSI (Received Signal Strength Indication), Link Quality, Data Rate, Transmit Power, Route Information, Neighbor information, etc. Link Monitor provides a unique graphical representation of the wireless network topology of a MOTOMESH Duo network after the devices are added and configured in the application.

Network Planning

Accelerated Deployment Using MeshPlanner™

One of the complexities involved in deploying a mesh network design is the difficulty in predicting the impact the environment has on network performance. Motorola's MeshPlanner addresses this issue by creating and utilizing an RF-intelligent map, which combines a basic map of the area, a list of possible mounting points for hardware, terrain data, and clutter information such as the location of buildings and foliage. Using this information, MeshPlanner software simulates the coverage and signal level that could be obtained from the deployment. MeshPlanner software is optimized for planning networks with MOTOMESH Duo. Unlike traditional site survey-based design methods which require costly and time consuming on-site work, designers can use MeshPlanner to plan the MOTOMESH Duo network on their PC, then validate the network's performance with site surveys using Motorola InFielder® software. This tool greatly accelerates the deployment of a MOTOMESH Duo network saving both time and money.

The Bottom Line: Minimizing Total Cost of Ownership

MOTOMESH Duo packs a lot of performance into one of the smallest and lightest form factors on the market today. With a low profile and slim-line aesthetics, the MOTOMESH Duo increases mounting location flexibility and community acceptance. As well, low power consumption can increase installation options and help reduce monthly operational costs.

Utilizing Motorola's proven MeshConnex routing engine helps minimize the number of wired and/or microwave backhaul links needed for capacity injection. Also, MOTOMESH Duo's self-forming and self-healing routing algorithm does not require a significant network re-engineering effort in response to changes in environmental topology. This design enables network operators the ability to simply add or subtract inexpensive elements in the infrastructure to respond to changing needs, without the necessity of frequent planning updates and redesign efforts.

Finally, the MeshManager network management system supports configuration templates and automates many of the configuration tasks during deployment and network optimization. These combined benefits minimize Total Cost of Ownership while helping to accelerate Return on Investment.

Connecting the Unconnected: The MOTOwi4 Portfolio

Motorola has been a global leader and innovator in wireless technology for over 75 years. Our expertise at "connecting the unconnected" has literally been proven all around the world. MOTOwi4 is a portfolio of innovative wireless broadband solutions that create, complement and complete IP networks. Delivering IP coverage to virtually all spaces, the MOTOwi4 portfolio includes Fixed Broadband, WiMAX, Mesh and Broadband Over Powerline solutions for private and public networks.

For more information about how Motorola's MOTOMESH Duo broadband public access solution can connect your customers or municipality to high-speed growth and success, call us at 1.800.795.1530 or 1.866.515.5825 or visit us on the Web at www.motorola.com/mesh.

MOTOROLA

Motorola, Inc.
1064 Greenwood Blvd. Suite 400
Lake Mary, Florida 32746 U.S.A.
www.motorola.com/mesh

Media Contact: Pam Benke
Email: pam.benke@motorola.com

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